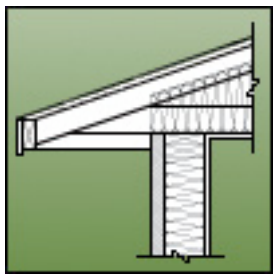

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FACT SHEET

ASSEMBLIES: ROOF

Description

Design and construction of the roof affects the structural, thermal and maintenance performance of the entire house. It also has an impact on the aesthetic aspects of the house, since choice of roof construction determines whether or not a house has flat or cathedral ceilings. In order to meet the goal of minimizing material resource impacts, we must consider the interaction of all components of the roof assemblies, and evaluate their relationships and performance in concert with each other. The following comparative analysis identifies the relative economic, energy, and environmental implications of four different roof systems: wood trusses, I-joists, structural insulated panels (SIP) and structural engineered panels (SEP).

Recommendations

SIP construction has the least environmental impacts due to reduced material resource use and increased energy efficiency. SIPs have a higher first cost, however, when combined with high performance windows, first cost may be offset by reduced sizing of the heating and cooling equipment.

The new SEP construction system may prove to be a low cost high performance alternative to both framing and SIP construction.

In general when planning exterior systems the following should be considered to reduce and eliminate environmental impacts.

- Use locally or regionally manufactured wood products to reduce transportation and increase community economic benefits. Wood framing used in this region comes from the Western or Southeastern US, as well as Canada. Panel products are manufactured within 500 miles and insulations are manufactured within 1000 miles.
- Use materials which maximize rapidly renewable resources: Exterior oriented strand board (OSB) uses fast-growing aspen and waste products; however, use materials from FSC-certified producers to ensure sustainable growing and harvesting practices and prevent use of 'plantation' grown products.
- Use less toxic materials: When selecting composites (OSB), use formaldehyde-free sheathing products to protect workers and installers from the production effects. Use expanded polystyrene or polyisocyanurate insulations which do not use HCFC blowing agents in panel construction (SEP and SIP).

Citations
Forest Stewardship Council (FSC): www.fscus.org A third-party certification organization established to promote sustainable growth and harvesting practices throughout the world's forests.

Roof Alternatives

alternatives	cost	material/s.f.-habitable		IAQ	LCT	practice
roof truss	TBD	lumber (b.f.) sheathing (s.f.) sheetrock (s.f.) insulation C (s.f.)	0.09 1.33 1.00 1.00	typical	typical	standard
I-Joist	TBD	lumber (b.f.) sheathing (s.f.) sheetrock (s.f.) insulation C (s.f.)	0.05 0.53 1.05 1.05	typical	better	standard
SIP	TBD	lumber (b.f.) structural sheathing (s.f.) sheetrock (s.f.) insulation C (s.f.)	0.01 2.11 1.05 9.49	better	better	requires training
SEP	TBD	lumber (b.f.) sheathing web (s.f.) sheathing (s.f.) insulation A (s.f.)	0.05 0.53 2.11 5.27	better	better	emerging technology

Criteria Summaries

Cost: Cost associated with roof framing are roughly 6% of the overall housing budget. Roof truss and I-joist construction fit within this general trend. Material costs for I-joists are less but may be absorbed by additional labor costs. SIP construction comes with a premium first cost of 15-20%, which translates to a 1% rise in whole house cost. Construction with roof trusses, SIP, and SEP require a crane for setting members, which may lend further economic benefit to the use of I-joists.

Materials: SIP construction has the minimum material use, combining structure and insulation. SEP and I-joist constructions use the same amount of lumber, this is due to the fact that the SEP roof utilizes I-joists for structural support . Raft truss roofs use the most lumber of the options presented. Raft trusses may prove to be advantageous for roof construction in 1-1/2 story homes if the bottom chord of the truss can be designed to act as the floor of the upper story. All the options reviewed use less material than traditional rafter construction utilizing 2x8 framing. Designs with cathedral ceilings have the added benefit of making small spaces seem larger and allow light deeper into the space.

Energy: Energy modeling of the roofing systems does not show appreciable differentiation between construction types. Calculations do not fully capture potential benefits of SIP and SEP roof assemblies which may outperform conventional construction systems due to decreased infiltration rates. Raised heal trusses are required to ensure full depth of attic insulation to the outer edge of the roof. Advanced framing in rafter built assemblies have higher actual R-value performance over traditional framing due to reduced thermal bridging.

IAQ: Mold development related to condensation within roof cavity systems is the primary operational concern; systems which eliminate roof cavities are at a lower risk. When properly air sealed, conventional systems can reduce the risk of mold development. IAQ due to material off-gassing in exterior wall material does not significantly impact operational IAQ since exterior walls materials are encased by finishes. Exterior sheathing does not pose off-gassing problems associated with interior finish selections.

Expected Product Life: Systems and products which do not support mold growth ensure longer-lasting construction. Protection against water penetration, infiltration, and exposure improves system and product life and performance.

Life Cycle Thinking: Evaluate materials on the following:

- Energy consumption (especially non-renewable, fossil fuel energy): Wood products require significant amounts of energy for processing and drying; gypsum products require more energy throughout every phase of their production.
- Pollutants generated in production: Plywood produces the least amounts of pollutants during harvesting and production, while OSB produces the most. Toxic materials are used in the production of most wood panel products, creating health issues for production workers. Select products that minimize toxic chemical use in their production, come from factories meeting highest EPA standards, and avoid formaldehydes which can off-gas to the atmosphere.
- Potential for out-gassing in the building: Because these are exterior products, and will be enclosed by other materials, their effects on the indoor environment are minimal.
- Durability of the product: If protected against moisture, either during construction or through the operational life of the building, gypsum sheathing and OSB have the longest life cycle. Plywood, because it can delaminate, is most susceptible to moisture exposure at all stages of its use.
- Potential for future recycling: Plywood has the most direct reuse potential, primarily because it can be downcycled one more step before being landfilled or used for fuel. However, in locations where gypsum board can be recycled into a soil amendment, it has the least long-term detrimental effects. Use of adhered moisture barriers, finishes and sealers can increase negative impacts when sheathings (interior and exterior) are composted.

Practice: Alternative roof systems require training for trades, and may include the use of more energy-intensive equipment (cranes for lifting SIP and SEP panels into place most efficiently, or additional crew members to handle the panels if cranes are not employed.) It is important to train all crew members when using SIP and SEP to ensure quality of construction. Large developments using alternative roof system construction methods will benefit from added efficiencies as crews carry experience from one unit to the next.